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Brain Breaks in Computer Science

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Abstract

The purpose of this action research study was to determine the effectiveness of brain breaks on behavioral engagement in middle school computer science classrooms. The two questions that drove this action research study were: should brain breaks be used in a middle school computer science classroom and do brain breaks help middle school computer science students stay engaged. This action research study was conducted in two middle school computer science classrooms in a Northeast Iowa school. Quantitative data was collected on behavioral engagement in both classes for 15 days which indicated the percentage of students behaviorally engaged and disengaged at three-time intervals each day. A qualitative analysis was completed with Google Form survey data that was given to the participants in each of the two classes.

Keywords: brain breaks, behavioral engagement, computer science, middle school

Brain Breaks in Computer Science

Computer science is a subject area that involves problem solving, critical thinking, decomposition, analytics, resilience, and perseverance. Teachers are finding it hard to keep their computer science students engaged because students become frustrated when trying to solve complex and challenging problems. Perseverance is needed so students do not give up when things become difficult. The tasks which are given to computer science students use higher order thinking skills and problem solving. The problem is that computer science teachers find it challenging to keep students engaged during class because students give up easily when things become difficult for them.

A brain break is a classroom strategy where the teacher pauses the class for a few minutes to shift the focus to some other form of activity. Brain breaks can involve relaxation activities, physical activities, or mental activities. After the brain break the students return to the instructional activity they were doing prior to the brain break. The purpose of this action research is to see the effect of brain breaks on student engagement in middle school computer science classrooms. The two questions driving this action research are: should brain breaks be used in a middle school computer science classroom and do brain breaks help middle school computer science students stay engaged. From this action research, middle school computer science teachers will see if brain breaks would be a beneficial thing to implement into their computer science classroom to help improve student engagement. This research will help indicate if brain breaks increase student engagement or not.

Research has been conducted using scholarly journal articles published in the last five years on student engagement and brain breaks. During the research process information was

gathered on engagement and disengagement in the classroom. The main focus of the research was on the use of brain breaks specifically in middle school classrooms.

Over the years, educators have worked hard to keep their students engaged and motivated to learn. The big challenge teacher's face with engagement and motivation is that students are all very different from one another which makes it difficult to find specific ways to engage and motivate them. Student engagement impacts learning and retention as well as grades and test scores. There have been indications that students become less engaged during middle school (Parsons, Nuland, & Parsons, 2014). Some middle school students find the new setting challenging because they have several different teachers, all with different rules and routines. Some students are less engaged in middle school because they don't see relevance in the different subject matters they are supposed to be learning and others are disengaged because their teachers don't personalize the lessons to meet the needs of each individual student. Because students can become more disengaged in middle school, it is critical that teachers rethink the strategies they are using to teach the content. Student engagement can be increased if teachers relate the content presented to the student's prior knowledge and experiences to promote buy in from the students. Before engagement can occur, students need to see a reason for them to learn the material. Over the year's teachers have used several different strategies and methods to increase student engagement. Some strategies to increase student engagement have been game-based learning, cooperative learning, hands-on projects, and authentic experiences for students. Allowing students, a chance for a brain break is another strategy that has recently been under investigation to help with student engagement.

This literature review will highlight what a brain break is, the different types of brain breaks, what student engagement is, ways to evaluate student engagement, and using brain

breaks in a middle school classroom. All of the criteria will present information on the effects of using brain breaks in middle school classrooms specifically computer science classrooms.

Literature Review

Computer science is a content area that involves perseverance, resilience, and self-motivation because students are encountering challenges and complex problems that require higher order thinking, critical thinking, problem solving, computational thinking, and decomposition to solve. Since tasks become difficult while taking a computer science class, students often give up and become disengaged in class. This literature review presents research about the background of computer science education, explores the concepts of brain breaks and student engagement. The literature review concludes with information specifically related to the implementation of brain breaks in a middle school computer science classroom.

Computer Science

Computer science involves programming computers or other machines to solve problems (Rich et al., 2019), which is a critical skill for students to learn. Computer science directly impacts so many aspects in the world including the amount of content that is on the internet and how students access and share information (Juskeviciene & Dagiene, 2018). Rich et al. (2019) are researchers who studied trends in teaching computing and coding to K-8 students. Rich et al. (2019) conducted a quantitative research study of 300 teachers from 23 different countries. In their study they gave a 20-minute survey to these teachers which included open ended questions to gather data on teaching computing to K-8 students. The data that was collected from their study was broken down into three main areas which included descriptions of teaching computing/coding, teacher preparation and personality, and experiences in teaching. Rich et al. (2019) concluded from the study three basic elements including: Scratch, Blockly, and Python

are the top three computing languages being taught in schools, 82% of the teachers teaching computer science have a math background, and coding should be a skill that is integrated into all subject areas in schools.

Umapathy et al. (2020) are researchers who also studied the concepts of learning computer science but at a collegiate level. Umapathy et al's (2020) conducted a quantitative study surveying 193 students from a southeastern United States university. The students in the study included 78% males and 22% females. The questions on the computer science survey were related to memorizing, testing, calculating, programming, increasing one's knowledge, application, understanding, and seeing in a new way. The questions in the survey were grouped into four factors which included surface motive, surface strategy, deep motive, and deep strategy. From their research Umapathy et al. (2020) concluded that students employ deep strategies in learning computer science which is where they make meaning of the subject and connect the subject to prior knowledge with new topics in computer science being learned. Umapathy et al.'s (2020) study showed that at the Southeastern United States University, many students that started the computer science program didn't complete the degree program and only 68% of those students passed the introductory programming course. Both researchers, Rich et al. (2019) and Umapathy et al. (2020), agreed from their research that computer science is a necessary 21st century skill that should be integrated into all school subject areas.

Both President Obama and Trump supported computer science education in legislation as well as financially because they felt that computer science is important to the United States economy (Umapathy et al., 2020). Several private companies in the United States such as Google, Facebook, and Amazon are supporting computer science education by providing

curriculum, grants, and other resources to K-12 schools so schools can teach computer science to K-12 students (Umapathy et al., 2020).

Computer science courses aim to equip students with a variety of skills such as: abstraction, decomposition, algorithmic thinking, pattern recognition, teamwork, effective communication, debugging, computational thinking, resilience, and perseverance (Ehsan et al., 2019). Teachers of computer science are finding it hard to keep students engaged in the computer science tasks because the students give up when tasks become difficult. The findings from Rich et al.'s (2019) survey from 300 teachers in 23 different countries found that 72.2% of teachers surveyed felt their greatest concern for teaching computer science was a lack of computer science knowledge and finding ways for students to persist through failures rather than just giving up. Rich et. al. (2019) found that in order for students to be successful in computer science courses, they need to develop resilience and "grit" to not give up when things become challenging or difficult.

Researchers Flanigan, Shell, and Soh (2017) conducted a two-part research study examining the computational creativity activities and their impact on student achievement. Part one of the qualitative study focused on a variety of program majors and part two of the study was conducted with engineering majors. The findings from the study concluded that computational creativity exercises had a positive impact on student grades and knowledge test scores as well as achievement in introductory computer science courses. Flanigan et al. (2017) research findings concluded that computer science involves creativity and computational thinking which proved to be the necessary skills required for student program success. Ehsan et al.'s (2019) re-emphasized the same necessary skills for computer science in a research study conducted in an informal learning environment where students were to use computational thinking skills and

creativity to create a safe place for a puppy. The unplugged activity of creating a safe place for a puppy taught the students several important computer science concepts such as breaking a problem down into smaller parts, critical thinking, problem solving, and algorithmic thinking. The students were grouped with three other classmates and they needed to use teamwork and effective communication as they worked through the task of making a safe environment for a puppy. The students needed to follow certain requirements as they were creating a safe environment for the puppy which included making sure the puppy could not run out of the yard, the environment needed to encourage that the puppy could get exercise, and the design needed to look nice. Based upon the findings in these research studies, it was evident that computer science classes provide benefits for students including computational thinking, creativity, collaboration, problem solving, and teamwork.

Computer science is an essential skill of the 21st learners in K-12 schools and educators are looking for ways to keep students engaged in the content. The findings from Umpathy et al.'s (2020) study found that students learn computer science best when they can personally make meaning of the topics and connect the topic to prior knowledge. A one size all approach does not work when teaching computer science. Giannakoulas and Xinogalos (2018) conducted a study to bring game-based learning into the computer science classroom to help with teaching abstract concepts and increase student engagement. Twenty 5th grade students participated in this mixed methods research study, where students were given a questionnaire about the impact of using games as a way of learning computer programming skills. The results from the study proved that games had a strong positive impact on the learning process while providing a level of fun which increased student learning engagement. Learning the skills in computer programming can be rewarding for the students but are not without challenges. Researchers Giannakoulas and

Xinogalos (2018) identified the challenges that arise from students to learn abstract concepts, develop problem-solving and decomposing skills while staying engaged in learning during the computer programming process.

Not only is computer science a challenging content area to teach, but an even bigger challenge is keeping students engaged so they can focus and learn the content area. Various types of brain breaks have been used in both elementary and secondary school settings as a way to increase student engagement in the classroom setting.

Brain Breaks Explained

A brain break is when the teacher pauses the class for a few minutes to shift focus to some other form of activity to allow students a chance to relax, breathe, refocus, and recharge. A brain break is when students are given physical and mental exercises to help keep them in the most receptive state for learning (Weslake & Christian, 2015). Weslake and Christian (2015) conducted their research in a 3rd grade math classroom where twenty-six students participated in the study. The study was conducted over a three-week time frame and each week a different type of brain break was given. This mixed methods research study collected data from student perceptions, student surveys, timed records of refocus times and teacher notes. Findings from the research study concluded that brain breaks helped reduce tension which helped students learn at high levels and kept the student brain active and alert. Students rated the relaxation and breathing brain breaks a low enjoyment rating. When physical brain breaks were given, student enjoyment increased and students regained focus four to seven minutes after the brain break activity. A content related game brain break was proven to gain student focus the quickest compared to the relaxation and physical brain breaks. In research by Weslake and Christian (2015), they found that physical activity increases dopamine production, which keeps the mind

active and alert leading to higher engagement in the classroom setting. These findings suggest that teachers should establish routine brain breaks in the classroom for a long enough period of time in order to see the effectiveness and evaluate the impact.

The purpose of Rizal et al. (2019) study was to measure the effect of Brain Breaks Physical Activity Solutions on the stages of change, decisional balance, processes of change, self-efficacy, and leisure-time exercise. One hundred and fifty-nine males and 263 females between the ages of 10 and 11 participated in this study. A mixed analysis study by Rizal et al. (2019) found that brain breaks improved student cognitive abilities, attitudes, and academic performance.

Egger et al. (2019) research used a mixed analysis study to examine the effects of long term cognitively engaging physical activity breaks on children's executive functions and academic achievement. This study took place in Bern, Switzerland where 142 children between the ages of 9 and 12 participated in the 20-week program. Egger et al. (2019) found that brain breaks had a positive impact on executive functions and academic achievement. Strong conclusions from Weslake and Christian (2015), Rizal et al. (2019), and Egger et al. (2019) research studies agree that the use of brain breaks in the classroom setting lead to positive student benefits including stress reduction, improving attitudes, improving academic performance, and improving time on-task behaviors.

In a quantitative research study conducted by Chang and Coward (2015), they discovered that there is a big difference in brain break time between the United States, Shanghai and Finland. In Shanghai, schools have 10 minutes of downtime for every 40 minutes of class (Chang & Coward, 2015). In the United States, the average amount of downtime or brain break time in an entire school day is only on average 26 minutes which includes lunch and snack time

(Chang & Coward, 2015), while in Finland, students receive a 15-minute break after each lesson (Chang & Coward, 2015). Dinkel et al. (2015a) and Dinkel et al. (2015b) have conducted two research studies on physical brain breaks. In Dinkel et al.'s (2015a) first study observed the perceptions of classroom physical brain breaks in two metropolitan midwest city school districts. Structured interview questions were asked to all twelve teachers in the school district and to one curriculum director. The results of the interview question from the teachers showed that teachers were in favor of implementing brain breaks in the classroom to improve student focus. Most teachers indicated that they felt confident with administering brain breaks in the classroom but were resistant due to the time factor. This finding explained why brain breaks are not being incorporated during the school day. In the second study by Dinkel et al. (2015b) four schools in a metropolitan midwestern city participated in the 38-question online survey. In this qualitative study, 88.2% of the teachers surveyed indicated that they provide physical brain breaks, but only half of these teachers provide the brain breaks on a daily basis. Sixty four percent of the teachers surveyed said that the reason they give brain breaks is to improve student behavior. Only 11.8% of schools in the United States require a physical brain break during the school day (Dinkel et al., 2015b). The research by Dinkel et al. (2015b and 2015a) proved the positive benefits of brain breaks in improving student behavior while Chang and Coward (2015) emphasized the importance of using brain breaks to reset the mind and refocus. Both researchers agree that brain breaks improve classroom management and eliminate disruptive student behavior.

Three types of brain breaks identified include breaks that involve breathing and relaxation activities, those that involve physical activities, and those that involve mental activities (Weslake & Christian, 2015). Breaks that involve breathing and relaxation involve

deep breathing exercises or meditation. Physical brain breaks involve movement and physical activity and mental brain breaks involve some form of learning activity or mental activity (Weslake & Christian, 2015). Researchers, Weslake and Christian (2015) found that mental content related brain breaks increased student engagement and time to refocus better than physical activity brain breaks and breathing and relaxation brain breaks.

Student Engagement

"When motivation to pursue a goal or succeed at an academic task is put into action deliberately, the energized result is engagement" (Liem & Chong, 2017, p. 138). Student engagement has been well researched over the years. Over time schools and students have changed especially the way students stay engaged. Some people identify engagement as time-on-task behavior; however, while further investigating, student engagement is actually more complicated than that because engagement is more than just observable behaviors (Parsons et al., 2014). Parson et al.'s (2014) study conducted in an urban middle school examined three dimensions of engagement: affective, behavioral, and cognitive. The findings of the research study concluded that teachers do have a direct impact on student engagement therefore teachers need to understand how students learn and provide students with successful learning opportunities.

Cornelisz and Klaveren (2018) conducted a qualitative study of 654 secondary students which looked at student performances on two versions of a computerized practice activity. One version was personalized and the other version was not. The study indicated the importance of establishing relationships between task difficulty and student performance because student engagement differs depending on if students like the task at hand and if they feel it is important to them. Likewise, Hamilton (2018) conducted a qualitative study looking at the need for

student engagement for learning to occur. Hamilton (2018) found that student time management practices have changed over the last few decades and most students do not manage their time well enough for lecture-based courses to be successful. Hamilton (2018) argues that teachers need to take the time to look at their individual students to provide experiences that are meaningful and engaging for all students. Both Hamilton (2018) and Cornelisz and Klaveren (2018) indicate that student engagement and motivation do vary from student to student.

From Hamilton's research (2018) he indicates that students learn less in lecture-based courses because that type of learning environment does not require students to engage in activities and be held accountable for their learning. In lecture base courses students need to remain focused and listen, but there is no one-on-one engagement happening. From Hamilton's research (2018), he presents the fact that there is indeed a direct correlation between engagement and the content learned and academic performance in the classroom setting; therefore, it is critical that academic time be structured in a way that will promote active participation and learning of students.

Researcher Groccia (2018) and Parsons et al. (2014) indicate that there are three main areas of student engagement which are cognitive, affective, and behavioral, which is contrary to researchers Liem and Chong (2017), who believes that there are four main areas of student engagement: affective, behavioral, cognitive, and psychological. Parsons et al. (2014) state that affective engagement is evident when a student feels connected with the teacher and the other students in the classroom setting therefore striving to be engaged by asking questions, actively participating while sparking interest and curiosity in learning. Parsons et al. (2014) state that behavioral engagement is observable and easily identifiable to the teacher and others. With behavioral engagement, the student will be working on and participating in the activity that the

teacher instructed them to work on. Finally, Parsons et al. (2014) indicate that cognitive engagement is engagement that can be displayed by a student's willingness to learn more than what is being taught in the classroom. A student who displays cognitive engagement will show signs of not giving up and the willingness to learn more than what is expected of them in their current classroom setting. So as indicated by several researchers there are three or four areas of student engagement. The researchers have indicated that cognitive, affective, and behavioral are the main areas of engagement with one researcher adding in psychological engagement.

The context and situation are two things that directly affect student engagement. A teacher can control the situation that is happening in his or her classroom by establishing set rules and routines for the classroom setting. Parsons et al. (2014) think this will allow for the teacher to have a positive social environment for the students which will allow them to be engaged in the classroom content; similarly, Cornelisz and Klaveren (2018) conclude that students need to see a connection before they will be engaged in the subject matter and adolescents tend to disengage when they face difficult tasks.

The academic activities that teachers assign are directly related to student engagement (Liem & Chong, 2017) and student engagement is a predictor of learning and personal development (Groccia, 2018). In order for a task to be engaging it must be authentic, collaborative, challenging, and include student choice meaning the students have ownership in the meaningful learning task which requires collaboration and pushes the students beyond their current competence levels (Afflerbach and Harrison, 2017).

Researchers, Afflerbach and Harrison (2017) indicate that engagement and motivation influence students and both are necessary in the classroom setting. Groccia (2018) indicates in his research that students who have a positive attitude toward the content area will be more

willing to be engaged by asking questions, completing the assigned tasks, and having persistence not to give up. Groccia (2018) indicates that the students will take their own initiative to do well in the content if they are motivated and interested in the subject area. Researcher Barkley, who was mentioned in Groccia's (2018) research, states that engagement involves both passion and excitement for the content area. Afflerbach and Harrison (2017) point out that motivation can lead to engagement, but motivation alone will not lead to engagement. Afflerbach and Harrison (2017) also indicated that motivation and engagement are closely related but they both have to be looked at individually and then after that a comparison can be made to see how one influences the other.

Researcher Groccia (2018) mentioned that there are so many different definitions of engagement that it is hard to make sure everyone is talking about the same thing. Groccia (2018) has prepared a model (which was adopted from Burns et. al 2004 and Groccia and Hunter, 2012) that indicates engagement as doing, feeling, and thinking and then there are branches of engagement which include engagement with other students, engagement in teaching, engagement in learning, engagement with the community, engagement in research, and engagement with faculty and staff. Groccia's (2018) multidimensional model of student engagement points out that engagement is an ongoing process to make sure students are learning at high levels. Engagement is such a complex topic that further investigations and studies need to take place to fully understand all aspects of engagement.

Parsons et al. (2014) defines high engagement as students who are actively involved in the learning situation which is indicated by students completing assigned tasks, students asking clarifying questions, and students not giving up when things become challenging and difficult. Parsons et al. (2014) explains that low engagement is when a student doesn't complete the task

that is assigned to them, but instead look bored and not involved in the assigned task and give up easily when the tasks become difficult and challenging. Afferbach and Harrison's (2017) research study measured student engagement through student self-reports, teacher reports, and observations. The student self-report used the Likert rating scale from "strongly agree" to "strongly disagree" as a way for students to evaluate themselves. The teacher report used the Likert rating scale from "very true of the student" to "not very true of the student" to gather the teacher's viewpoints. Observations included student on-task and off-task behavior documented by the teacher and adult observer. From this study, Afferbach and Harrison (2017) conclude that motivation and engagement are closely related and that one does influence the other. Even though student engagement has been well researched for over 70 years the research indicates that there are still several underlying questions.

Using Brain Breaks in a Middle School Setting Computer Science Classroom

Adolescence is a sensitive time in a child's life because of the many changes that are taking place in the child's body and at school (Olivier et al., 2019). Typically, students in middle school start switching classrooms and have several different teachers throughout the day which is different from the elementary school setting where students usually stay in one classroom all day and have one primary teacher. Students in elementary school typically only interact with the students in their own classroom, but in middle school since the students switch classes after a period of time, they tend to have an increased amount of peer interactions. Middle school is where extracurricular activities become a priority in the student's routine where students are spending more time dedicated to practices and rehearsals, which in turn can lead to stress and disengagement in school (Martinez & Zhao, 2018). Stress is a "physiological response to the perception of loss of control resulting from an adverse situation or person" (Martinez & Zhao,

2018, p. 1). Researchers Martinez and Zhao (2018) indicate that there is a direct relationship between stress and engagement which means if a student feels stressed it will be hard for them to engage in the classroom setting. Researchers Olivier et al., (2019) discovered that since so many changes happen to children during adolescence, adolescent children are at an increased risk for becoming less engaged in the school setting since it is such an unsettling time for them. In middle school student's stress levels can increase because of physical changes happening in the child's body when puberty hits, peer interactions and peer relationships, or family situations (Martinez & Zhao, 2018). When a student becomes stressed it can cause the student to become angry, violent, and act poorly in the classroom which makes it very hard for the student to concentrate and become engaged in the classroom activities (Martinez & Zhao, 2018). Researchers, Martinez and Zhao (2018), highlight that if a student is unable to self-monitor they often act out in ways that could get them reprimanded or in trouble in the classroom making it hard for engagement to occur. If a student is disengaged the student will miss important academic content which will have a negative impact on their future academic performance and success.

Weslake and Christian (2015) point out in their research that brain breaks need to be chosen carefully and then monitored to see their effectiveness. According to Chang and Coward (2015), a teacher's instructional strategies are not enough to keep students engaged in the classroom. Specific research related to offering brain breaks in a middle school computer science classroom was not found in prior research. The prior research that has been conducted has indicated that brain breaks can help increase engagement in the classroom setting, but none of the studies specifically studied the effects of brain breaks on student engagement in a middle school computer science classroom. Since there have been indications that students become less

engaged during middle school and students in computer science classrooms are faced with challenging tasks that oftentimes lead to student frustration and the need for perseverance and grit to get through them, a further investigation of offering brain breaks during a middle school computer science class is warranted.

Brain breaks have been proven to increase student engagement; however, because there is a gap in the research on the effectiveness of brain breaks on student engagement in middle school computer science classrooms further research is needed to fully understand the effectiveness of brain breaks on student behavioral engagement for middle school computer science students. This action research project will focus on the effect of brain breaks on student behavioral engagement in a middle school computer science class. All three types of brain breaks will be studied which include breaks that involve breathing and relaxation activities, those that involve physical activities, and those that involve mental activities. Behavioral engagement will be studied during the proposed action research project.

Methodology

Research Questions

The purpose of this action research was to examine the effect of brain breaks on behavioral engagement in middle school computer science classrooms. The two questions that drove this action research included: should brain breaks be used in a middle school computer science classroom and do brain breaks help middle school computer science students stay behaviorally engaged. From this action research, middle school computer science teachers will be able to conclude if brain breaks would be a beneficial practice to implement into their computer science classroom to improve student behavioral engagement. This research study examined if brain breaks increase or decrease student behavioral engagement in the classroom.

Research Design

Two middle school computer science classes were used in this study; one class received brain breaks and one class did not receive brain breaks. Mixed methods were used in this action research study. Quantitative data was collected each day while break breaks were given. Data on behavioral engagement was observed and documented on the behavioral engagement tracking document in five minutes intervals after the brain breaks were given. Quantitative data indicating student behavioral engagement was collected in the computer science class that did not receive brain breaks 20, 25, and 30 minutes into the class period. Qualitative data was gathered from a survey given to students in the two computer science classes. Each class was given a survey at the end of the data collection period. The survey questions were customized based on whether the students were given brain breaks or not.

Variables

The independent variable in this action research study was the use of a brain break in the middle of a computer science class period. Brain breaks were added to the middle school computer science classroom setting and data was collected on whether or not adding a brain break increased behavioral engagement.

The dependent variable in this action research study was behavioral engagement. Data was collected to see if behavioral engagement were changed when brain breaks were added into the middle of a middle school computer science class period.

Setting and Participants

This action research project took place in two 8th grade computer science classes in Northeast Iowa. The school where this study was conducted has 669 students with 5,600 students that make up the school district with nine elementary schools, two junior high schools,

and one high school. The computer science class where this study took place is called Coding, App and Game Design which is an elective course for 8th graders.

The class that received the brain breaks had 13 students which included four females and nine males. Three students in the class had Individualized Education Plans (IEPs) and two students had 504 plans. The class that did not receive the brain breaks had eight students and all of the students are males, none of which have an IEP or a 504 plan.

Data Collection Plan

Each day half-way through the 43-minute class period a brain break was given to one of the two middle school computer science courses. Brain breaks from three different categories were given on a rotation for 15 class periods. The three categories of brain breaks given included relaxation break breaks, mental brain breaks, and physical brain breaks. Data was collected by a classroom paraeducator on student behavioral engagement 5, 10, and 15 minutes after the brain break was given. The data collected documented who was behaviorally engaged in the course content and who was not. Student behavioral engagement included working on assigned tasks, facing the teacher or partner, and being on the correct computer tab. Student disengagement included online gaming, talking to peers about off topic subjects, doodling, spacing off, head down, or sleeping. Data was also collected by the teacher in the class where no brain break was given after 20, 25, and 30-minute segments into the class period. This data indicated the number of students behaviorally engaged and the number of students disengaged. Comparisons between the two classes were made to see if having a brain break impacted student behavioral engagement.

A final anonymous survey was administered via Google Forms to all students in both classes. The students that received brain breaks were asked questions relating to the use of the

brain breaks in the computer science class period. One of the questions on the survey asked the students to use a Likert scale ranging from 5 to 1 (from very enjoyable to very unenjoyable) to indicate their experiences of having a brain break in class. The survey asked students which type of brain break helped them to stay focused the best, their attitude towards classwork after receiving a brain break and the feelings they felt after receiving a brain break.

The students that did not receive brain breaks also completed a survey. The questions on the survey were viewpoints of brain breaks, what emotions brain breaks could bring, whether or not the students felt a brain break would help them stay behaviorally engaged in class, and whether or not they feel brain breaks should be given in a computer science classroom. A place was provided on the survey where students could expand on their answers with details.

A tally sheet was created using Google Sheets. The brain break class tally sheet included the date, the name of the brain break, the category of the brain break, and the number of students engaged and disengaged for each of the three data collection points. The tally sheet for the class that did not receive a brain break included the date, and the number of students engaged and disengaged for each of the three data collection points. Each day the tallies were transferred to a daily documentation spreadsheet that was also created in Google Sheets. The spreadsheet was in a password protected Google account and the daily tally sheet was kept in the teacher's desk which was locked. The survey instrument used was similar to survey instruments used in previous action research studies backing up the reliability and validity of the survey instrument that was used in this study.

Data Analysis Plan

The data analysis process included a look at the mean percentage of students engaged and disengaged at the different time intervals that the data was collected in both classes. Data was

analyzed as a whole by the mean and then it was broken down based on the different categories of brain breaks given. The data was then compared to see if there were a greater percentage of students engaged versus disengaged in the class that received brain breaks compared to the class that did not receive brain breaks.

The survey data was analyzed by the number of responses for each number of each Likert scale. The qualitative data collected from the survey was read through and categorized by theme or topic of responses.

IRB Approval

IRB approval was granted from Northwestern College's IRB board. The board granted the permission to use the designated survey instrument to gather data on the use of brain breaks from students in two computer science classes. Each student's legal guardian who participated in this action research study was emailed a permission form to grant permission for their child to participate in this computer science brain break survey. The permission forms were collected and stored in a password protected email account.

Findings

Data Analysis

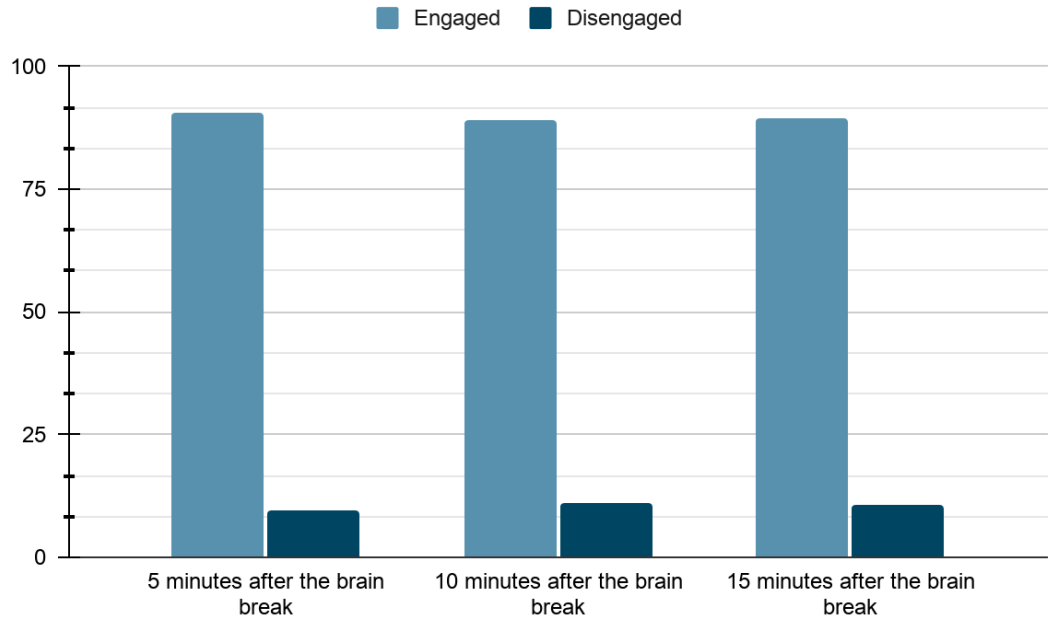
For this action research project, the teacher researcher used both qualitative and quantitative data points to assess the impact of using brain breaks on student engagement in a middle school computer science classroom. Qualitative data was collected daily in two middle school computer science classrooms. One of the classes received brain breaks and the other class did not. Data was collected in three five-minute increments, counting the number of students behaviorally engaged and the number of students not behaviorally engaged at those points of time. Quantitative data was collected from a Google Form survey about brain breaks and the

usage of brain breaks at the end of the qualitative data collection period. To summarize the data collected, all of these data points were used.

Three different types of brain breaks were given on a three-day rotation for 15 days which included relaxation, mental, and physical. The mean overall behavioral engagement percentage for the 15 days can be seen Figure 1. As indicated from this data, the average percentage of students engaged five minutes after the brain break was 90.45% of the students and 9.55% were disengaged. After 10 minutes of receiving a brain break the average percentage of students engaged were 89.11% and 10.89% were disengaged. Fifteen minutes after the brain break was given 89.36% of the students were engaged and 10.64% of the students were disengaged.

Figure 1

Average Percentage of Student Engagement and Disengagement for the Class with Brain Breaks



In addition to the class that received brain breaks, data was collected and analyzed for the middle school computer science class that did not receive the brain breaks. The data collected from the class that did not receive brain breaks can be seen in Figure 2. Data was collected in 5-minute increments starting halfway into the class period. During the first data collection checkpoint, 99.17% of the students were on average behaviorally engaged and only 0.83% were disengaged. During the second data collection checkpoint, 95% of the students on average were behaviorally engaged and 5% of the students were disengaged. During the last data collection checkpoint 91.67% of the students on average were behaviorally engaged and 8.33% of the students were disengaged.

Figure 2

Average Percentage of Student Engagement/Disengagement for the Class without Brain Breaks

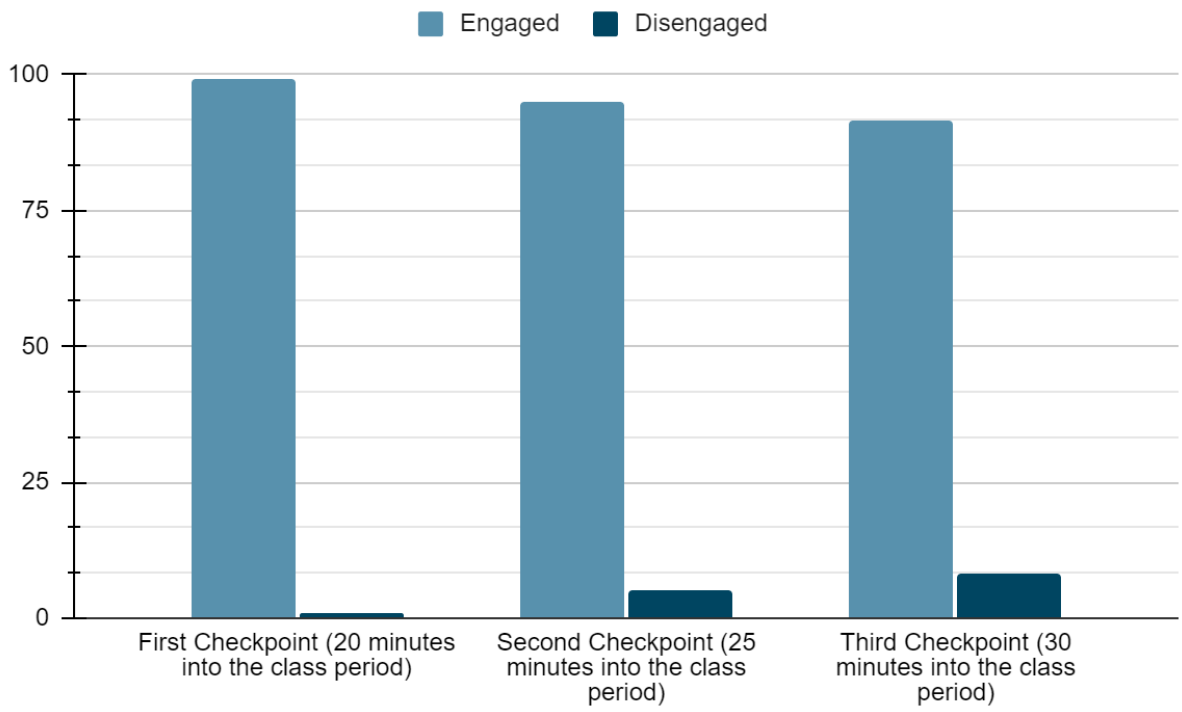


Table 1 shows a comparison between the class that received brain breaks and the class that did not receive brain breaks. The average percentage of students engaged and disengaged is indicated in this table as well as the percentage difference between the two classes.

Table 1

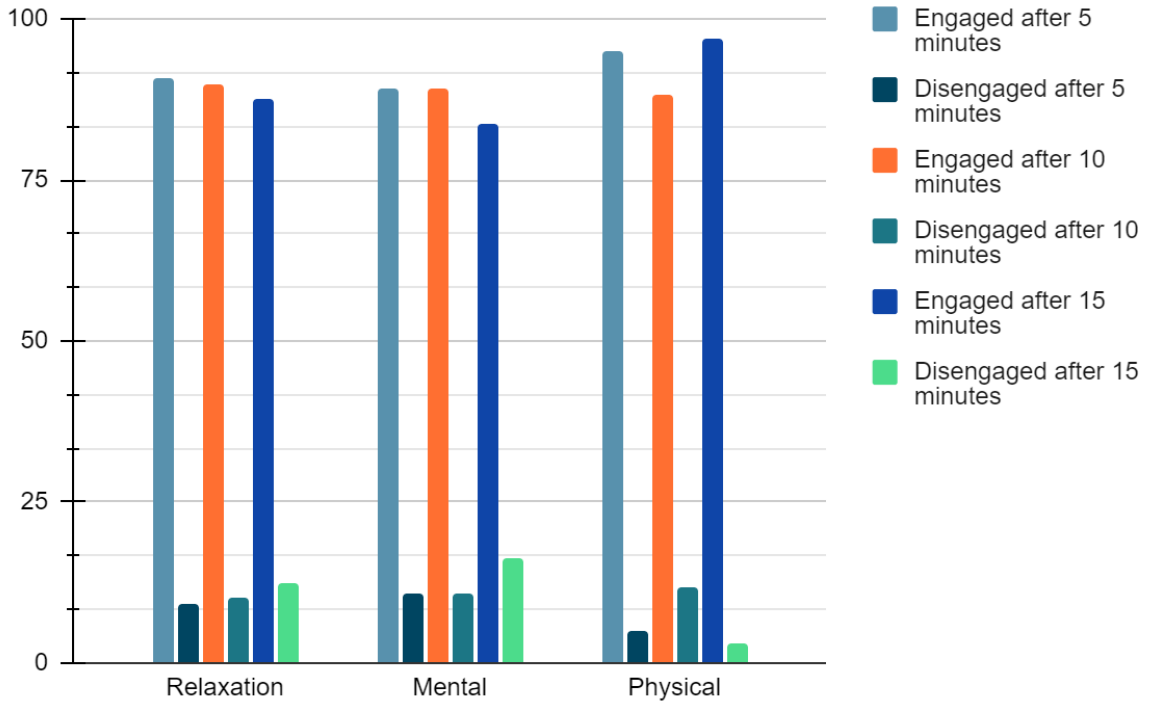
Comparison between the classes with brain breaks and without brain breaks

Time Interval and Engagement	Brain Break Class %	No Brain Break Class %	Difference
5-minute data point (Engaged)	90.45%	99.17%	8.72%
5-minute data point (Disengaged)	9.55%	0.83%	8.72%
10-minute data point (Engaged)	89.11%	95%	5.89%
10-minute data point (Disengaged)	10.89%	5%	5.89%
15-minute data point (Engaged)	89.36%	91.67%	2.31%
15-minute data point (Disengaged)	10.64%	8.33%	2.31%

Data was also analyzed based on the type of brain break (relaxation, mental, and physical) that was given to the students. Figure 3 highlights the average number of students behaviorally engaged and disengaged for each of the three types of brain breaks for the three different time frames where data was collected.

Figure 3

Average Percentage of Student Engagement and Disengagement for the Three Types of Brain Breaks



For each of the three types of brain breaks, five different brain breaks were given. The five relaxation brain breaks included belly breathing, flow balloon relaxation YouTube video, mindful minutes YouTube video, breath in and out, and color by Boolean. On average after five minutes of having a relaxation brain break, 90.68% of the students were behaviorally engaged with 9.32% of the students disengaged. On average after 10 minutes of having a relaxation brain break, 89.7% of the students were behaviorally engaged with 10.3% of students disengaged. The average percentage of students behaviorally engaged after 15 minutes of receiving a relaxation brain break was 87.48% with 12.52% of the students being disengaged. The five mental brain breaks that were given included: letter spots, height line up, conditional creatures, brain puzzles, and secret messages. On average after 5 and 10 minute intervals of having a mental brain break 89.34% of students were behaviorally engaged with 10.66% of the students disengaged. After 15 minutes of receiving a mental brain break, the average number of students behaviorally engaged was 83.67% with 16.33% who were disengaged. The five physical brain break games

that were given were called: this or that, would you rather, dice game, snowball, and paper twirling. These physical brain break games got the students up out of their seats and moving around the classroom. After five minutes of receiving a physical brain break, on average, 95% of the students were behaviorally engaged with 5% of students disengaged. After 10 minutes of receiving a physical brain break the average percentage of students who were behaviorally engaged was 88.29% with 11.72% who were disengaged. After 15 minutes of receiving a physical brain break the average percentage of students who were behaviorally engaged was 96.92% with 3.08% of the students being disengaged.

After the 15-day brain break data collection period, an anonymous survey was given via Google Forms. Eleven students from the class that received the brain breaks participated in answering the survey. All 11 students gave a neutral or enjoyable rating response to the question about their experience of having brain breaks in the computer science classroom. Seven students indicated that their favorite type of brain break activities were the physical activity brain breaks and four students indicated that their favorite type of brain break activity was the mental brain breaks. No student responded with the relaxation brain breaks as being their favorite.

Students were asked to describe their attitude toward classwork after they had a brain break. Seven students indicated that they were ready to focus and return to work after the brain break. Two students stated that they were energized, very focused, and ready to work hard after receiving the brain breaks and two students gave a neutral rating toward classwork after receiving the brain breaks. Some of the emotions that the students reported feeling after the brain breaks were joy, focused, bored, interested, and engaged. Nine out of eleven students surveyed indicated that they feel brain breaks should be given a middle school computer science while two of the students surveyed indicated that brain breaks were not needed.

Various viewpoints were given about what students liked and disliked about the brain breaks. Several students indicated that the brain breaks were boring and that they wished they were optional in terms of participation. The relaxation brain breaks were the least favorite type of brain break that was given. At least four students indicated that the brain breaks were a disturbance because they felt their focus was interrupted by the brain break and that they had a hard time refocusing. One student suggested that brain breaks should be incorporated in a health class more so than in a computer science course. Another student indicated that the brain break helped them to relax their mind so debugging of the code was easier after receiving a break.

The class of eight students that did not receive brain breaks participated in an anonymous Google Form survey at the end of the data collection period. All of the students responded with a neutral or enjoyable rating when asked their viewpoints of brain breaks. Four students indicated that brain breaks could bring them joy and were in favor of adding them to a course to make the course subject matter more enjoyable. Another four students indicated that brain breaks would help them with focus and engagement. Five students believed brain breaks should be given in a computer science class where three students felt that brain breaks should not be given because it was more of a bother rather than a benefit because of the loss of concentration. A reason given for giving brain breaks was to help the brain refresh, become more focused and engaged. One student suggested that brain breaks would be beneficial on certain days of the week compared to being offered every single day.

Discussion

This study has demonstrated that brain breaks do not increase student engagement in a middle school computer science classroom but rather suggest that there is not a direct impact on the use of brain breaks on student behavioral engagement. From the data that was collected and

analyzed from this study, it can be concluded that a higher percentage of students in the class without brain breaks were behaviorally engaged compared to the class that did receive brain breaks. In the class that received brain breaks, there were a lower percentage of students engaged compared to the class that did not receive brain breaks.

From the qualitative data that was collected there was a split view point on whether brain breaks should be given in a middle school computer science. Some students indicated that brain breaks would be beneficial in regaining focus while others indicated that brain breaks are more of a nuisance than a beneficial activity in terms of increased focus and engagement.

The analysis of the data from this study indicated that brain breaks don't increase student engagement in a middle school computer science classroom but rather decrease the behavioral engagement slightly. In this study, it is noted that physical brain breaks were the best type of brain breaks for increasing student engagement compared to the relaxation and mental brain breaks. This was contrary evidence from Weslake and Christian's (2015) study which indicated that mental content related brain breaks increased student engagement and focus compared to physical activity or relaxation brain breaks. This research study as well as Weslake and Christian's (2015) study agree that brain breaks need to be chosen carefully and monitored to see the effectiveness of the brain break on student engagement.

Based upon the findings of this study it can be suggested that further research is needed in terms of measuring student engagement using non-elective computer science courses to see if similar results are found. Since this action research study was conducted in an elective computer science class further investigation is needed to see if similar results are found in a required computer science course.

There were several limitations to this study. This study was conducted in two elective computer science classes where all of the students chose to take the course where they are more likely to be engaged in the content. Another limitation to this study was the small sample size of only 21 participants. A final limitation to this study was the short data collection period of fifteen days where data was collected on the effectiveness of brain breaks in terms of student engagement.

Based on the findings from this study a future study of the effectiveness of brain breaks in a required middle school computer science class rather than an elective class would be beneficial. It is recommended that in a future study the data collection period be longer than 15 days to gain a clear picture of the effectiveness of brain breaks in terms of student engagement. A study that encompasses a larger participation population compared to just 21 participants would be recommended.

Conclusion

Computer science teachers find it challenging to keep students engaged during class because students give up easily when things become difficult. This action research study looked at the effectiveness of using brain breaks on student behavioral engagement in two middle school computer science classrooms. The results of this action research study indicated that brain breaks do not increase behavioral engagement in middle school computer science classrooms but rather decrease behavioral engagement slightly. The quantitative data that was gathered in this study showed the computer science courses that incorporated brain breaks had lower average percentage rates of student engagement than of the courses that did not incorporate brain breaks. Based on the qualitative data that was collected a mixed viewpoint of brain breaks was given. Some students felt that brain breaks helped them stay focused and engaged while several other participants indicated that

brain breaks were a nuisance because of the loss of concentration and refocusing efforts needed after the brain break. This results of this study implied that brain breaks can be beneficial for some students but not for all students.

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